The Policy Practice

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Rwanda's Electricity Boom and the Danger of Too Much Power

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Key Insights

Electricity is vital to modern societies, underpinning basic services, the economy and many recreational activities. The electricity sector, and, increasingly, energy generation, is becoming a focus of international development (e.g. Sustainable Development Goal 7 and the African Union's Programme for Infrastructure Development, updated in the recent ambitious Agenda 63).

In sub-Saharan Africa, the majority of governments have launched ambitious strategies to significantly increase their national installed power capacity. However, booms in electricity generation can be 'too much of a good thing' as they can harm economic progress. This is especially true when governments decide to increase generation through private sector engagement, because this often entails:

- Building too many generation plants – but having to pay for the power they make available;
- Taking on too much public risk to entice private sector companies; and
- Choosing technologies that do not meet the power grid's demands.

Ironically, for the continent with the worst access to electricity in the world, overcapacity is a significant danger in Africa's electricity boom.

Rwanda is a striking example of this problem. Its capacity grew from 40MW in 2003 to over 200MW today, involving the completion of 43 plants in 16 years, with an additional 13 underway. The result will be an installed capacity of 570MW by 2026. In contrast (over)optimistic forecasts suggest a maximum on-grid demand of 309MW by 2026. This is particularly problematic as it includes over 400MW of 'take-or-pay' contracts.

This expansion will be costly. Rwanda already has one of Africa's highest customer tariffs and its most expensive system costs. In 2017/18, the government had to pay the equivalent of 1.4% of national gross domestic product to plug the fiscal gap; the World Bank predicts that this may have already reached 4% in 2020/21, before all Power Purchase Agreements come online.

Recommendations

For donors:

- Support rigorous demand forecasting.
- Exercise more caution about advocating and instigating private solutions for the electricity sector. Include careful consideration of the risks and subsidies African governments can bear.
- Increase support to the scrutiny of electricity plans, especially by civil society.

For governments in Africa:

- Listen to internal critical voices within the civil service and government, as well as frank, external advice. These play a key role in improving and sense-checking policy.
- Ensure civil servants are able to incorporate their knowledge and external expertise into policy-making and advice.
- Exercise more caution about turning to private sector solutions for the electricity sector. This includes appreciating the risks of take-or-pay power projects and careful consideration of how much to provide in terms of subsidies.

Photo on front cover: Nyabarongo Dam, Muhanga District, Southern Province, Rwanda © Dr Barnaby Joseph Dye

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Acronyms

BTC	Belgium Technical Cooperation
DFID	Department for International Development
EU	European Union
GIZ	German Development Cooperation Agency
kWh	Kilowatts
MW	Megawatts
PPA	Power Purchase Agreement
RPF	Rwandan Patriotic Front
USAID	United States Agency for International Development

1 Introduction

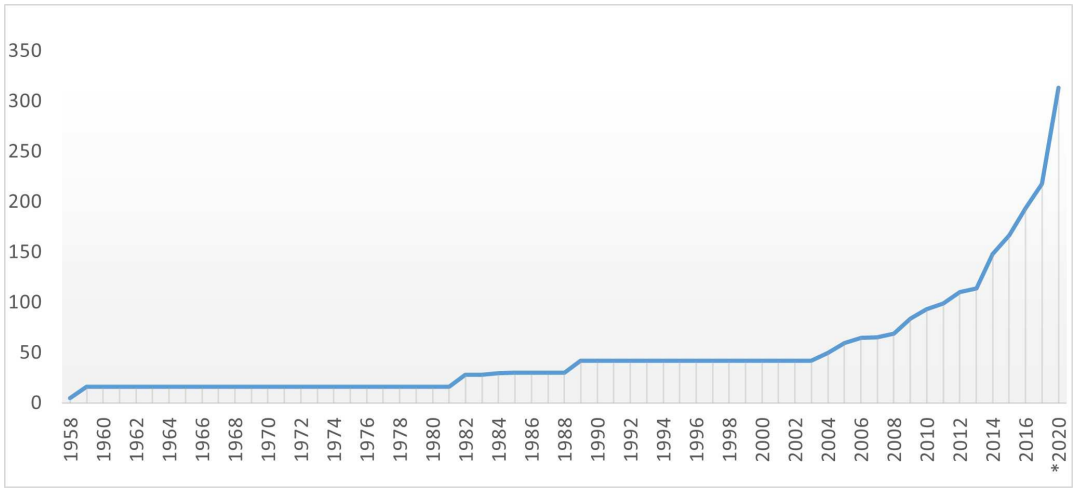
Over the past decade, Rwanda has undergone a large increase in electricity generation. Official statistics suggest that the country will reach an installed capacity of 313MW by the end of this year, up by almost 750% from the level in the mid-2000s.[1] This surge has entailed the completion of 43 projects since 2004; 13 are still under construction.

Achieving this rate of increase, even from a low base, is remarkable for a land-locked, economically poor nation that is still recovering from the horrors of the genocide. Equally impressive is the range of technologies Rwanda has chosen to develop. Hydropower remains dominant but the government has diversified to almost all the available indigenous energy sources, including the rarer peat and the globally novel methane gas dissolved in Lake Kivu. In the latter two cases, the government supported pilot plants to prove the concept before contracting private companies to build larger plants.

Given Rwanda's low baseline and rapid economic growth, a significant increase in installed megawatts was needed. However, Rwanda's dramatic increase in capacity, far from proving a boon for development, could derail progress.

This Rwandan case is instructive for developing countries in Africa and beyond. It demonstrates that, amid increasing global attention to universal energy access and boosting generation, awareness of the dangers of overcapacity and private sector participation in power plants is needed.

Figure 1: Rwanda's remarkable recent megawatt surge – installed electricity generation, 1958–2020 (MW).



Source: Author's calculation based on official Ministry of Infrastructure/Rwanda Energy Group statistics.

[1] Going from 41.95MW to 313.57MW by the end of 2020 represents a 747% increase.

2 Why Is Rwanda's Energy Boom a Problem?

2.1 Over-capacity

The principal oversight in Rwanda's energy boom relates to overestimates of demand for the power system. As Figure 2 shows, the agreements signed between the government and the projects under construction will take the country to around 570MW by 2026. However, forecasts have long predicted electricity demand of roughly half of that figure. A recent analysis found that, for 2020, peak demand would be between 162MW and 187MW; for 2026, a high-growth scenario (10% increase in demand per year) would still lead only to 309MW, still more than 250MW short of installed capacity (REG, 2019, p. 11).

Meanwhile, these estimates were already overly optimistic, given Rwanda's historic growth; the ongoing corona virus pandemic suggests demand is likely to rise even less steeply.

The daily profile of electricity consumption in Rwanda gives more detail to this picture. The country has a pronounced evening peak in electricity use, given that the overwhelming majority of electricity use is among residential customers and businesses such as hotels. For the majority of the day, demand on the grid is typically a third lower than during the evening peak demand period.

A significant gap will therefore exist between peak demand and electricity supply and an even larger gap will be present for most of the day.

2.2 Debt

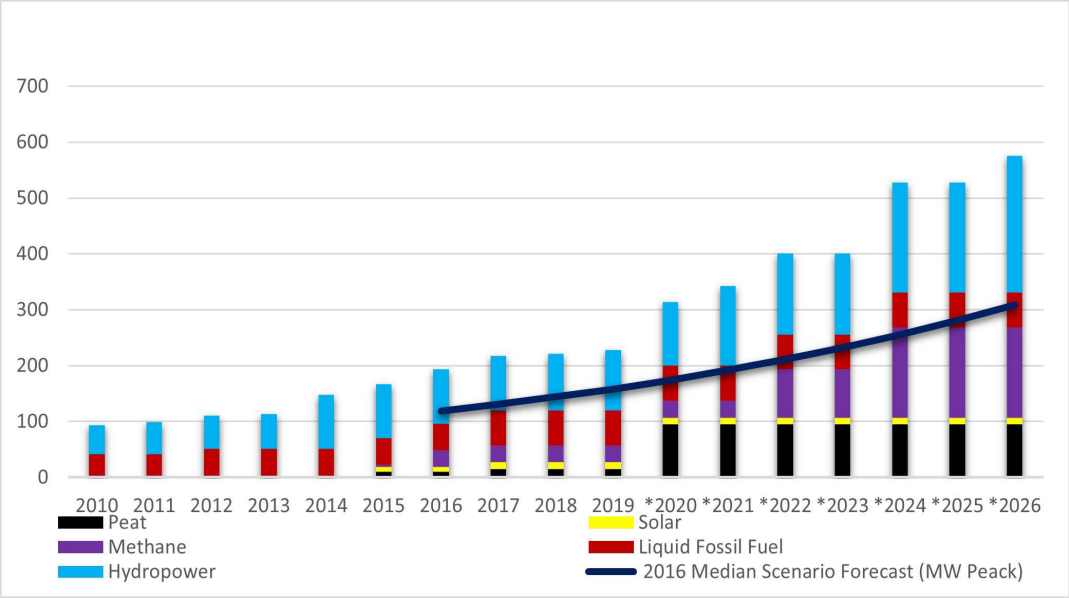
Oversupply can cause two types of debt problem. The first relates to power plants that are financed through the government raising money on international markets or receiving subsidised development bank loans. Normally, the assumption is that they will pay off these loans as more electricity generation supports more economic growth, which increases tax revenue. A non-performing electricity plant will not create this positive cycle, and therefore not directly provide the government with the additional revenue to pay off such loans.

The second issue stems from finance agreements with the private sector. Here, the government does not take on debt directly but rather signs an agreement with a private firm, which itself raises money and constructs and owns the plant. Such contracts are risky, as they include an obligation to pay for the electricity produced. To ensure the investor can make a return, the electricity utility buying the energy normally signs a Power Purchase Agreement (PPA) with a 'take-or-pay' clause. This ties the electricity utility to paying the investor for typically 90% of the power it makes available, regardless of whether it is used or not.

In addition, to attract private companies to build plants, governments typically need to further reduce investors' risk. This can include paying them in an international currency or providing subsidies such as basic infrastructure (roads, grid connections, etc.) and tax exemptions. In some countries, deals have even been known to guarantee investors' returns, although this has not occurred in Rwanda.

Deals with the private sector to generate electricity have tended to involve governments taking on significant risk of guaranteeing payment and providing subsidies.

Figure 2: Demonstrating the plans for electricity generation against predicted demand – generation capacity in Rwanda by technology, 2010–2026 (MW).

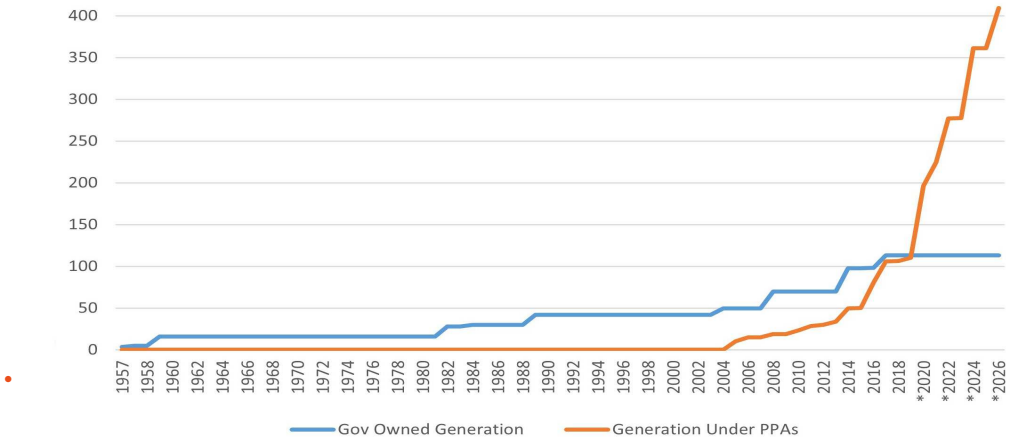


Source: Author's calculation based on official Ministry of Infrastructure/Rwanda Energy Group statistics.

2.3 Oversupply and Private Sector Power Purchase Agreements in Rwanda

Rwanda contracted the majority of its new plants through the PPA method. As Figure 3 shows, in 2019, both the government and private investors owned about 110MW of generation capacity each. However, once those projects currently being implemented are commissioned, private sector PPAs will account for four times the generation capacity of government plants. Given the forecast of limited future power demand, these PPA payment obligations are likely to push Rwanda's state electricity utility into significant debt (Dye, 2020).

Figure 3: The increase in private sector power plant ownership – government- vs. private sector-owned installed megawatts, 1957–2026.



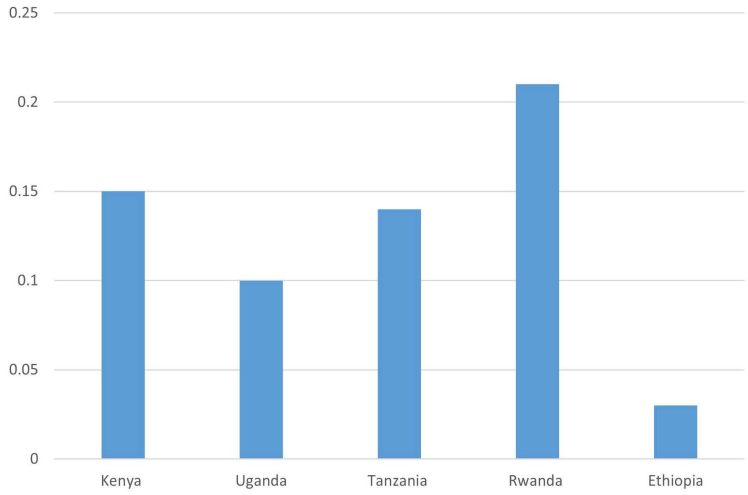
Source: Author's calculation based on official Ministry of Infrastructure/ Rwanda Energy Group statistics.

2.4 De-risking Measures

Additionally, the government provided a raft of de-risking measures to encourage private investors, pricing its PPA deals in US dollars, building roads and grid connections to each new power plant site and agreeing relatively generous tariffs (Chemouni and Dye, 2020). Generous PPA deals in excess of $20 cents per kWh[2] have translated into continuing expensive electricity for customers: Rwanda's electricity tariffs, at $0.21 per kWh in 2018, are among the highest in comparison with the sub-Saharan African median of $0.15 in 2017 (World Bank, 2017), and have long been the highest in the East Africa region.[3]

This is particularly problematic for Rwanda's comparative attractiveness to transnational companies, especially export industry, which tends to require rates of under $0.7 per kWh to be able to sell to international markets and compete in global value chains. Additionally, it is a problem for selling Rwanda's power to regional neighbours on the emerging Eastern African Power Pool. In theory, Rwanda could sell its surplus power to neighbouring countries but, as Figure 4 shows, doing so would be unprofitable.

Figure 4: Selective electricity tariff comparison of main regional rivals ($ per kWh)



Source: Complied by author from official statistics and Muchira (2018).

[2] This is especially true for the micro-hydro projects.

[3] Rwanda has long ranked first or second in comparative tariff surveys (Economic Consulting Associates, 2010; Chemouni and Dye, 2020).

Another cost pressure has come from the pricing of PPAs in US dollars. To increase investor certainty, the Rwandan government priced its PPAs in dollars rather than Rwandan francs. This has proved costly, with the continual appreciation of the dollar against the franc, further ramping up 'real' prices of electricity and requiring government subsidisation (World Bank, 2017; Chemouni and Dye, 2020).

2.5 The Cost of Rwanda's Approach

Already, by 2016, Rwanda was in the African top 10 in terms of costs of servicing the electricity system and the gap between the cost and revenue per unit of electricity (Kojima and Trimble, 2016). The World Bank predicted this gap would grow from $0.12 per kWh in 2017 to over $0.30 by 2020 (ibid.). To date, the government has stepped in to finance the electricity utility's debts, costing 1.4% of Rwanda's gross domestic product (GDP) in 2017/18. However, this has already risen, with the Bank predicting that, by 2020/21, a business-as-usual scenario would see this subsidy equal 4% of GDP.

Rwanda's use of PPAs, and its attempts to de-risk the sector for electricity investors, has made the sector less financially stable.

The government has reacted to the risk of oversupply and high tariffs. In 2013, a 1000MW target was reduced to the more technocratic-sounding figure of 563MW but this was also not based on realistic demand forecasts.[4] Further steps were taken in 2016, when the government introduced measures to halt further power plant deals, stop some incentives and delay projects. A final acknowledgement came in 2018 and 2019 with more rigorously produced revised demand forecasts. However, these measures have come too late to stop overcapacity without breaking existing contracts, which would create significant financial penalties and could damage the country's reputation with regard to future private sector agreements.

2.6 Hydropower

One area that remains overlooked is Rwanda's reliance on hydropower. As Figure 2 shows, hydropower has been the country's sole technology for power generation for most of its history, and remains the major contributor today. This reliance has continued for three reasons: its abundance; its status as an established technology; and the fact that some plants, like Nyabarongo I Dam, are Rwanda's cheapest power source.

Meanwhile, the government has overlooked the sectoral and socio-environmental risks of the technology. The most obvious of these is the displacement large dams like Nyabarongo I, Rusumo Falls and the upcoming Nyabarongo II cause, given the high population density in Rwanda.

Other issues are made worse by the concentration of hydropower plants in the Nyabarongo River Basin – a sub-catchment of the Nile. For example, hydropower plants alter river flow according to electricity needs. This changes river hydrology from the conditions to which ecosystems and farming are adapted.

[4] Rather, the forecasts were significantly massaged to produce a 'political' figure (Dye, 2020).

Dams also trap fertile sediment that would otherwise support floodplain farming and habitats. This phenomenon is particularly pronounced in Rwanda, given its rivers' high sediment load. Sediment accumulation also reduces the storage capacity of hydropower reservoirs like Nyabarongo and damaged the first round of micro-hydro plants in the country.

Relying heavily on hydropower also creates vulnerability to drought. Historically, rainfall shortages have affected Rwanda significantly, causing seasonal, often severe, blackouts. Choosing to build so many hydropower plants therefore comes with risks and downsides that Rwanda did not factor into its planning process.

Rwanda's hydropower dependence also carries risks to farming and the environment, and is vulnerable to the climate.

3 The Politics Behind Rwanda's Electricity Boom

3.1 Rwanda's 'Political Settlement'

To explain why and how the boom in power plants occurred in Rwanda, it is necessary to understand the structure of political power in the country and the nature of the state. Since the genocide in 1994, the Rwandan Patriotic Front (RPF), led by President Paul Kagame, has governed Rwanda.[5] The state officially looks like a democracy, with the rule of law, parliaments and regular elections. But formal and informal power is strongly centralised with the president and a small group of leading political–business–military families. This leads to an authoritarian style of governance, but one marked by cohesion of the ruling elite and the centralisation of policy-making, with dissent against the ruling establishment suppressed. [6]

Given this unrivalled grip on power in the country, this cohesive authoritarianism enables Rwanda's rulers to focus on the future. Without the need to fight expensive elections and worry about their short-term political survival, President Kagame and the senior RPF figures have the power to direct the country's private sector towards longer-term investment in strategic sectors. Their longer-term thinking also incentivises the prosecution of corruption and cronyism within the civil service.

For the energy sector, this has meant that, once the political leadership had decided key targets, and had made construction of electricity generation plants a priority, the Ministry of Infrastructure and the government-owned electricity utility[7] were under significant pressure to deliver. Their role was not primarily in policy formation; the presidency decided this. Rather, the government was there to implement.

The degree of centralised power and the authoritarian nature of Rwanda's state also made it hard to question the high-level targets for power production. With the presidency and party officials demanding results, ministers and civil servants had to focus on developing all available power sources.

Rwanda's highly centralised political power supports a leadership with longer-term ambitions but also a particularly hierarchical, implementation-focused policy-making practice.

[5] At first more informally, given that Kagame was Vice-President.

[6] See Reyntjens (2013), Jones (2014), Behuria (2015, 2016), Goodfellow (2017).

[7] Whose name changed from Electrogaz to RECO (Rwanda Electricity Company) to EWSA (Electricity Water and Sanitation Authority) to REG (Rwanda Energy Group) and subsidiaries EDCL (Electricity Development Corporation Limited) and EUCL (Electricity Utility Corporation Limited).

3.2 A Modernising Vision of Development

The Rwandan political elite's ideas mattered in this pursuit of an energy boom. Academic studies point to the influence of a development ideology that understands progress as technological modernisation (also called 'high modernism')[8]. Rwanda's officials appeared to believe that the construction of energy generation would produce demand and that technology could by itself lead to economic progress irrespective of other structural constraints. The limit to Rwanda's power plant building should therefore be its own ambition and ability to mobilise, not any predictions about what the system needed: build it and they will come (Dye, 2020). Consequently, civil servants and politicians massaged demand forecasts to predict far higher electricity needs, thereby justifying the power plant construction boom.

The Rwandan elite's idea about what development is and how to achieve it favoured rapid electricity expansion irrespective of demand forecasts.

3.3 Capacity in the Bureaucracy

In order to implement this electricity boom, Rwanda needed a capable bureaucracy. Here, Rwanda's wider political dynamic was again formative. The country's political elite, with its focus on long-term development and on disciplining corrupt practices, has helped create a focused, relatively effective government bureaucracy (Chemouni, 2016). The Rwandan state has also instilled a strong work ethic. It famously uses a stringent performance target system known as *Imihigo,* to which individual's jobs and minister's positions are effectively attached (Klingebiel et al., 2016). This capacity and the pressure to deliver targets were a key ingredient in rapid action to process the 56 plants that are due to come online by 2026.

Rwanda's relatively meritocratic and capable bureaucracy was hierarchically directed to focus on narrow implementation targets.

3.4 The Role of Donors

The Western donor community supported the planning and delivery of this electricity drive. The German Development Cooperation Agency (GIZ), Belgian Technical Cooperation (BTC), the Africa Governance Initiative and the Overseas Development Institute supplied international experts to the Ministry of Infrastructure and government's electricity utility. They helped with planning and delivering individual projects and setting up private sector projects. The World Bank supported the study of potential micro-hydro sites and general budgetary support came from many donors, including the EU, the UK Department for International Development (DFID) and USAID.

Donors also provided project financing and capacity: Power Africa and the World Bank provided regulation, legislation and institutional support, while GIZ, BTC, the World Bank, the United Nations Industrial Development Organisation and the EU gave out private sector micro-hydro loans. Additionally, for Nyabarongo I Dam, the Indian government provided concessional finance through its ExIm Bank.

[8] Ansoms (2009), Dye (2016), Huggins (2017).

This significant role for donors might have allowed them to question the planning process leading to the oversupply crisis. Indeed, consultants embedded in the Ministry of Infrastructure warned against the high target and persuaded the president and senior ministers to undertake the revision from 1000MW to 563MW. Japanese experts supporting forecast planning also predicted far lower demand but their conclusions were overruled. Officials from the EU, DFID and the World Bank also warned the government against its rapid generation programme. However, the state resisted all partners until after 2016 – when the PPA deals had already been signed.

This fits a well-noted pattern (Hayman, 2009; Marriage, 2016), whereby Rwanda maintains a high degree of independence from Western donors, despite their considerable financial support. This stems from the state's assertion of its sovereignty, its ability to play on Western donors' guilt over the 1994 genocide and its utilisation of implementation capabilities to win over Western donors, which increasingly need to demonstrate concrete outcomes as part of their aid effectiveness agenda.

Moreover, Rwanda's ability to resist donors is reinforced by the aforementioned, pyramidal centralisation of power with the president and a select group of key, party political decision-makers. Ministries are largely positioned as implementers of such higher policy-making. This structure reduces opportunities for donors to influence policy-making, particularly in this case, given that their main engagement with electricity planning was through the Ministry of Infrastructure and electricity utility (Chemouni and Dye, 2020; Dye, 2020).

3.5 Mobilisation of the Private Sector

Alongside this governmental support, Rwanda mobilised domestic development financing. This involved the state-owned Rwandan Development Bank and the Rwanda Green Fund (Fonerwa). Additionally, more clandestine development funds were utilised. The RPF owns the investment fund Crystal Ventures, while the military has Horizon, both of which are routinely used to finance strategic development. The electricity boom was no exception, with Horizon, for example, backing the creation of Ngali Energy, which has become the largest micro-hydro developer.

The government also encouraged the country's politico-business elite to invest in this electricity boom. This saw RPF-connected businesses like the Rwanda Investment Group enter the sector, not least because such projects offer a legitimate source of rents (i.e. profits from public sector activity). Arguably, such private contracts, with their limited oversight compared with those in the public sector, offer a means to reward the RPF-connected elite, although there have been no notable corruption allegations in the sector to date.

In total, 30 companies, the majority of which are Rwandan, are responsible for running, or have developed, 43 micro-hydro dams. Additionally, Israeli and US companies have developed Kivu Methane gas and a Turkish firm Hakan is completing the larger peat plant.

Rwanda achieved rapid electrification with strong enrolment of Western donors, international finance and companies alongside Rwandan funds and the politically connected private sector.

4 Conclusion

Rwanda has placed a high priority on the rapid construction of power plants. With pressure stemming from the top of government and pushed through the hierarchical decision-making process that characterises Rwanda, all forms of domestic electricity technologies have been pursued. Established technologies, like hydropower, have proceeded quickest, alongside pioneering lake-gas extraction, which has required extensive mobilisation and organisation of international and national actors. But with the strong focus on installed megawatt targets hard to contest, the risks of the government's 'megawatt mission' have been overlooked. The result is a growing crisis of overcapacity and likely indebtedness.

Rwanda is not alone in Africa in facing these challenges. Other countries on the continent have fallen into similar oversupply traps. Ghana, for example, contracted double what the country's electricity system needed between 2014 and 2016. Significant corruption is suspected in this case, particularly with the renegotiation of a PPA in 2017 that failed to improve terms for the state utilities.

Additionally, Ethiopia has now built enough hydropower plants to satisfy between two and four times what peak demand is, with more on the way. The focus on installed megawatts has overlooked other crucial parts of the electricity system, such as a transmission grid to distribute the electricity. Moreover, overreliance on hydropower causes dry season power cuts.

Rwanda does not present the worst case of oversupply problems because it has a proven ability to learn and change direction (Behuria, 2017, 2018). Even if it reacted too late in this case, by 2019 a substantial policy shift had taken place. But Rwanda's experience has important lessons for other countries and for donors.

5 Lessons: What can be done to avoid power-sector debt traps?

One might argue that Rwanda's power system issues are surprising, as the country has a cohesive and stable government with a long-term vision and a reasonably meritocratic and capable bureaucracy. However, these were not sufficient to chart an economically or socio-environmentally sustainable course for the sector. There are a number of takeaways here for policy-makers and advisors working on electricity generation:

1. **Ideas about development matter.** The government's belief in technology's ability to create demand was a central driver of both progress and the ensuing problems.

2. **Involving the private sector involves significant risks.** In particular, there are dangers of signing contracts for too many megawatts, of pricing PPAs in international currency and of providing too many subsidies. For those countries with uncertain on-grid demand and a delicate fiscal position, the benefits of financing development through the government have been underestimated.

3. Rwanda's bureaucracy needs to shift from an overly top-down, hierarchical service to appreciate:

a. The need for the bureaucracy to incorporate its expertise and **technical advice** to inform policy-making, for example in the formulation of demand forecasts.

b. The crucial role of **critique and challenge to policy-makers**. The civil service should be able to speak truth to power and sense-check policy. Working alongside politicians, it should be able to question and improve the political goals and priorities the ruling party has set.

4. Donors should specifically consider:

a. Support for **rigorous demand forecasting**.

b. Support for the **interrogation and questioning of electricity-sector plans** within government and, crucially, by more independent civil society actors.

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